Educ.
LB
1647
.A1
S4

SCHOOL OF EDUCATION
LIBRARY

MAR 21 1950

The Science Teacher

Including

THE ILLINOIS CHEMISTRY TEACHER

Volume IV MAY, 1937 Number 2

IN THIS ISSUE---

Organic Chemistry in the High School...Nicholas D. Cheronis 1
Chemistry for Professional Value.....John C. Bailar, Jr. 5
Principles Involved in Chemical Warfare.....Ray C. Soliday 8
Chic-Embryo Biology Project.....H. L. Slichenmyer 10
National Geographic School Service..... 12
Illinois Biology Curriculum Program..... 13

THE NEXT ISSUE, in part---

Use of Germs in Warfare.....F. W. Tanner
University of Illinois, Urbana, Illinois
The Essence of First Aid.....Joseph H. Beard, M. D.
University of Illinois, Urbana, Illinois
Photography as an Extra Curricular Subject.....M. E. Woodworth
Pittsfield High School, Pittsfield, Illinois
The First Course in Chemistry.....H. T. Briscoe
Indiana University, Bloomington, Indiana
Demonstration of Dry Ice.....Edward Zetterberg
Muncie High School, Muncie, Indiana

Published Quarterly During the School Year

Free*—*A New Monograph

SCIENCE AND LIFE

It offers help in planning a foundation science course that meets the needs of pupils today—a course that will help pupils to understand the world they live in and to solve environmental problems of everyday life.

Based on a successful two-year foundation course—

- **The Pieper-Beauchamp Science Program**

EVERYDAY PROBLEMS IN SCIENCE

EVERYDAY PROBLEMS IN BIOLOGY (with O. D. Frank)

It offers suitable materials for carrying out the aims of modern science education in a life-centered curriculum.

- **Supplementary Materials for the Pieper-Beauchamp Science Program:**
  Study Books . . . Objective Unit Tests . . . Teacher's Guidebooks

NEW: **Unit Graphs for EVERYDAY PROBLEMS IN BIOLOGY — a set of twelve wall charts covering the subject-matter of the twelve units in the text. Special postpaid price $1.00. Size 18" by 21".**

SCOTT, FORESMAN AND COMPANY

CHICAGO • ATLANTA • DALLAS • NEW YORK

COMPANION TEXTBOOKS

OF THE

DYNAMIC SCIENCE SERIES

DYNAMIC BIOLOGY
(Baker-Mills-Connor)

DYNAMIC CHEMISTRY
(Biddle-Bush-Connor)

DYNAMIC PHYSICS
(In Preparation)

Designed to fit the interests, needs and abilities of high school students.
Based upon nation-wide investigations of courses of study, and upon modern principles of teaching.
Written by successful high-school teachers, checked for thoroughness and accuracy by scientists and expert teachers, edited by education experts.
Organized into modern teaching or learning units, with ample provision for study guides and teaching aids.

Let us tell you more about the Dynamic Science Series

RAND McNALLY & COMPANY

536 South Clark Street **Chicago, Illinois**

The Science Teacher

Including

THE ILLINOIS CHEMISTRY TEACHER

VOLUME IV | MAY, 1937 | NUMBER 2

Organic Chemistry in the High School*

NICHOLAS D. CHERONIS

Wright Junior College — Chicago, Illinois

The question of what place the study of organic compounds should occupy in a course of high school chemistry might well be viewed from three angles: First, as to whether the study of organic compounds should be included in the course at all; second, examination of the place that it occupies at present in most high schools and critical examination of the material included in the textbooks; and finally, suggested changes in arrangement and presentation of the material to accomplish the objectives of the course.

With reference to the first point, that is, whether the study of organic compounds should be included in a course of high school chemistry, there is general agreement in the affirmative. If one of the objectives of high school chemistry is to give the student an idea of the material world in which he lives through the observation of the most important transformations that matter undergoes, then undoubtedly the study of organic compounds has a prominent place for we live in an organic world; and fuels, foods, textiles, most of the common things with which we come in daily contact are compounds of carbon.

The place that the study of compounds of carbon occupies in most high schools has been summarized as follows: "The study is well summarized in the outlines, and it is usually left for the end of the second semester for no other reason than that most texts put it there. Usually time is pressing at the end and if something is to be omitted, the organic compounds ordinarily suffer".** This omission might also seem justified by the experience of many teachers who have tried to present something which they felt at the end did not even penetrate, to say nothing of its having been absorbed.

The greatest obstacle, however, is the nature of the subject itself, whose very complexity renders a brief survey of the organic compounds extremely difficult. A bewildering accumulation of facts with but few correlated principles contrives to confuse the relations between the vast number of organic compounds. As yet, there is no periodic table in organic chemistry. The study is perplexing even to the average college student, who after a semester, is dazed and confused. The greatest difficulty is that we have not developed a brief survey of the compounds of carbon based on principles and adaptable to the high school level.

In order to determine what material is included in the average high school chemistry books, six texts on the approved list of the Chicago High Schools were examined for content. The aver-

*Illinois High School Conference—Urbana, Illinois. November 6, 1936.

**Private communication from a high school teacher.

age number of pages devoted to organic compounds is about 65; the maximum being 140 and the minimum 38. The topics and arrangement of the material in all follow practically the same pattern. All begin the study of organic compounds as something distinct. There is no attempt to project the material into a background with which the student is already familiar, but he is immediately plunged into the vast number of organic compounds; petroleum products and cracking, the paraffin series, unsaturated benzene and acetylene series, then a paragraph or two as to the halogens, alcohols, phenols, ethers and several pages on an assortment of topics such as soaps, foods, rubber, rayon, alkaloids, poisons, vitamins, explosives, dyes, anaesthetics, etc. There is a dearth of principles which will give the relation between two groups of compounds. Naturally, most of the material is factual, similar in nature to what appears in the Sunday sections of some metropolitan newspapers. The student will read it, and even if he succeeds in memorizing the vast array of unrelated facts, he will forget them. Simple facts do not constitute a science—not even a popular science.

Perhaps, the above judgment may sound too severe. One is always suspicious of critics, for although it is realized that every system, institution or idea must be subjected to the purifying torch of criticism, still the demand is made that the censor offer not only concrete basis for criticism, but also some plan for the elimination of unsound parts of the structure, some way to accomplish the objectives more effectively. Perhaps we have been led to this by half-informed opportunists, who, in order to attract attention, attempt to show their learning by criticism of the accepted.

The proposed unit is based on two or three weeks' work and includes such topics as fuels and foods, which are given in most high school courses. The method of introduction given in this outline has been found very useful in the General Survey Course of Physical Sciences given in the Chicago City Junior Colleges.

The study of the carbon compounds must begin with an introduction which attempts to relate the new material to what the student already knows. This can be accomplished by starting with a discussion of the mineral world in which silicon is the chief element. The following shows how such an introduction may be outlined.

I. The element carbon.

1. **The mineral and organic worlds.** The crust of the earth is made of rocks which contain minerals in varying proportions. The minerals are mostly composed of **silica** and metallic oxides. The fundamental element of the mineral world is **silicon.** Plants and animals are composed of an organization of **cells** and are called **organisms.** The aggregate makes up the organic world. All plant and animal tissues contain compounds of carbon which may be considered the fundamental element of the organic world.
2. **The position of carbon and silicon in the periodic system.**
   a. Carbon and silicon belong to Group IV.
   b. Show analogous allotropic forms.
   c. Ability to unite with other atoms of the same kind to form chains or rings. Such compounds from silicon are unstable. Those of carbon are relatively stable.
   d. Dissimilarity in the oxides of carbon and silicon. SiO_2, solid, high melting point and not easily reduced; CO_2, a gas, low melting point, easily reduced. The ease of reduction is shown in the utilization of carbon dioxide by plants in photosynthesis.
3. **Sources of organic compounds.**
   a. Probably all carbon in combination existed at the time of the formation of the earth as CO_2. With the beginning of life, the cycle of carbon began.
   b. Natural gas, petroleum, coal are complex mixtures of organic compounds. They contain mostly carbon and hydrogen—hydrocarbons. They were formed by the slow decomposition of plant or animal tissues buried under water or earth.
   c. From plants and animals: sugars,

Sch of Ed Lib.
Dept
3-15-50

starches, vegetable oils, gelatine, etc.

d. The chemical laboratory: The chemist breaks larger molecules into smaller ones (cracking), or makes larger ones from smaller (synthesis).

4. **The rise of organic chemistry.**
   a. Brief mention of Wohler's experiment.
   b. Rapid rise in 100 years—reasons, both theory and application.
   c. Modern tendencies—synthetic fuels, liquefaction of coal, synthetic rubber. Organic chemistry and the depression.

The next topics for consideration are the structure, complexity and classification of organic compounds. The following is an outline for a method of approach.

II. The structure and complexity of compounds of carbon.

1. **Elemnts found in organic compounds.**
   a. Few elements are found—C, H, O, N and the halogens make up more than half a million compounds.
   b. As an example, the compounds found in natural gas may be considered: methane, ethane, propane, butane, pentane.
   c. There are three different compounds with the formula of C_5H_{12}—**isomerism.**
2. **Structural formulae and reaction properties.**
   a. The difference in the three pentanes is explained by different arrangements of the five carbons and the twelve hydrogens.
   b. Another more striking example is the case of two compounds which give on analysis a formula of $C_4H_{10}O$. One is the familiar **ether** used in surgery; the other is obtained by the fermentation of sugar by a certain bacillus in absence of air.
   c. Demonstration of differences:
      (1) in rate of evaporation, from their boiling points.
      (2) in odor.
      (3) in reaction properties, for instance, with sodium metal.
   d. Explanation with structural formulae. In ether all the hydrogen atoms are bound to carbon. In the alcohol, we have a hydroxyl group which, to a certain extent, behaves as it does in water.

The simple experiment outlined above brings home strikingly the theory of the structure of organic compounds. All students are acquainted with ether by name. Now, by analysis the formula is found to be $C^4H^{10}O$. The student is given another compound, butyl alcohol, which also has the formula $C^4H^{10}O$. The two compounds are isomers. He is asked to make note of their odor, rate of evaporation of a drop, and reaction with a tiny bit of sodium. He sees that compounds are different. Now he can be asked at a later date to write all possible forms of arrangement of these fifteen atoms. This also introduces the idea of the structural formula to account for the reaction properties of the compounds.

3. **Classification of organic compounds.**
   a. For the sake of study, the multitude of organic compounds are classified into groups which have related properties and therefore similar structure.
   b. Hydrocarbons may be considered as the parent substances of all other compounds of carbon.
   c. By replacement of one hydrogen of methane by chlorine, CH_3Cl is obtained (Methyl chloride). If we replace it with a hydroxyl, CH_3OH (methyl alcohol) is derived.
   d. **The concept of the radical.** A radical is a group of atoms which in the ordinary chemical reactions behave as one atom (SO_4 and NO_3 are known to the student). Similarly, we can write CH_3-H for methane, CH_3CH_2-H for ethane, where CH_3 is the methyl and C_2H_5 is the ethyl radical. We can represent all organic radicals by the letter R. Then R-H represents hydrocarbons, R-Cl a halide, R-OH an alcohol, etc.

This leads into a brief discussion of the most important groups of organic compounds and their properties. The hydro-carbons are introduced through discussion of natural gas and petroleum.

III. Brief discussion of the most important groups of carbon compounds.

1. **Hydrocarbons.**
   a. Hydrocarbons of natural gas: methane, ethane, propane, butane. Their structure has already been given.

(Continued on page fourteen)

THE SCIENCE TEACHER

201 North School Street, Normal, Illinois

A Journal of
The Illinois Association of Chemistry Teachers
And Serving
The Illinois Biology Teachers' Association
The Indiana High School Chemistry Teachers' Association
And Other Science Associations

John C. Chiddix—Editor and Business Manager
Normal Community High School, Normal, Illinois
P. K. Houdek—Assistant Editor
Robinson Township High School, Robinson, Illinois
W. Glen Tilbury—Advertising Manager
Urbana High School, Urbana, Illinois
S. A. Chester—Asst. Advertising Manager

CONTRIBUTING EDITORS

R. W. Parr—University of Illinois, Urbana, Illinois
Howard W. Adams—Illinois State Normal University
Normal, Illinois
John C. Hessler—James Millikin University, Decatur, Illinois
Mabel Spencer—Community High School, Granite City, Illinois
E. L. Stover—Eastern Illinois State Teachers College
Charleston, Illinois
Arthur C. Brookley, Thornton Township High School and Junior College, Harvey, Illinois

OFFICERS OF
THE ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS

George C. Ashman—President
Bradley Polytechnic Institute, Peoria, Illinois
Ray Soliday—Vice President
Oak Park and River Forest Township High School, Oak Park, Illinois
C. A. Gross—Vice President
Carbondale High School, Carbondale, Illinois
L. T. Lucas—Vice President
Lakeview High School, Chicago, Illinois
Theodore Nelson—Vice President
Decatur High School, Decatur, Illinois
Herman R. Rahn—Vice President
Mattoon High School, Mattoon, Illinois
S. A. Chester—Secretary-Treasurer
Bloomington High School, Bloomington, Illinois

OFFICERS OF INDIANA
HIGH SCHOOL CHEMISTRY TEACHERS' ASSOCIATION

Edward Zetterberg—President
Muncie High School, Muncie, Indiana
Herbert S. Rice—Vice President
Vincennes High School, Vincennes, Indiana
June E. Ossenberg—Secretary-Treasurer
Martinsville High School, Martinsville, Indiana

OFFICERS OF
ILLINOIS BIOLOGY TEACHERS' ASSOCIATION

Grace L. Cook—President
Champaign High School, Champaign, Illinois
Louis A. Astell—Vice President
University High School, Urbana, Illinois
Mary R. Earnest—Secretary-Treasurer
Decatur High School, Decatur, Illinois

Subscription rates: In the United States, 75 cents a year or $1.25 for two years; in Canada, $1.00 a year or $1.50 for two years. THE SCIENCE TEACHER is published quarterly during the school year.

INDIANA WELCOME

We believe that science associations can profit most by cooperating and working with those of other states, especially in the use of a journal like The Science Teacher. So we heartily welcome the Indiana High School Chemistry Teachers' Association in joining with us in this work. We believe this Journal will be able to help them in a very personal way to achieve their goals as an association.

The action was taken by the Indiana Association at its meeting April 17 at Indiana University, Bloomington, Indiana.

CURRICULUM REVISION

One of the most hopeful indications of virile science courses for high schools is the present trend of curriculum revision now under way in Illinois, Iowa, and other states. Revision of courses through the scientific selection of objectives in keeping with present needs and the selection of subject matter that is a part of the student's life experience will place natural science courses in a preferred position in meeting student needs. Instead of a declining enrollment in physical science classes we may expect a rapid increase comparable to that in general science and biology in recent years.

Curriculum revision is something that cannot be accomplished quickly; neither can it be done by a few educational experts and then handed to the teachers to use. Rather it must come as an outgrowth of thinking on the part of every teacher using the revised curriculum Of course the thinking should be under the direction of capable educational leaders in the field.

In the State of Louisiana a system of curriculum revision is being used that is worthy of consideration. There all the teachers of the school system make a thorough study of the curriculum both individually and in local groups and have a part in its revision. The fact that each teacher actually studies the problem and helps in the revision means that each teacher will have a fair understanding of it and will be able to use it according to his ability to make readjustments in teaching.

Chemistry For Professional Value

JOHN C. BAILAR, JR.

University of Illinois Urbana, Illinois

Chemistry is usually considered a prerequisite for training in agriculture, engineering, medicine and other scientific professions, and many of our students undertake its study with that thought in mind. Unfortunately, most of these students and many of their teachers seem to feel that the value of chemistry lies in the factual knowledge which it represents. Without doubt, this factual knowledge is extremely important, but there are other equally important values which these students should find in their study of chemistry.

A knowledge of chemistry is essential to anyone who attempts to keep abreast of scientific developments as may be seen from the chemical terms and explanations of any journal of geology, botany, bacteriology or other science. If reading in these journals is to be pursued with either pleasure or profit such terms must be so familiar to the reader that he grasps their full meaning quickly and without effort. The language of chemistry may be simply an adjunct to the science itself, but it is a very important adjunct. Scientific ideas, to be of value, must be expressed exactly, and many of them cannot be expressed exactly in every day terms.

It is now often necessary for all scientific men to be able to think and express themselves in terms of chemistry. The medical schools have seen the need of this, and their laboratories are equipped with apparatus for the study of pH, microanalytical determinations, colloidal chemistry, electro-chemistry, and many other branches of the science. It is not sufficient that a doctor be able to recognize the symptoms of a disease and prescribe a treatment. He must know what chemical changes in the body have produced the disease, and what chemical effect the treatment will have.

A similar change in point of view has appeared in agriculture. The old fashioned farmer thought of the growth of crops in a purely empirical way—the soil was taken for granted as a gift of Providence and as long as it produced crops, it received no treatment of any sort. Today, the agricultural expert considers the soil as an ever changing bed of chemicals and thinks of the application of fertilizers in terms of the elements which they supply.

It is difficult to impress this point of view upon our students, for like all other young people, they are prone to consider the fundamentals as being too difficult or too impractical to be of value. The teacher must be ever alert to show the usefulness of a thorough understanding of the basic facts and theories of chemistry. Lacking such guidance, the boy learning to be a farmer may find nothing of value in balancing equations, and the budding engineer may well ask "Will studying atomic structure help me in designing a Diesel engine?"

It is the duty of the teacher to build up the student's faith in the worth of chemistry and to teach him how to use its principles. As chemistry teachers, we profess to believe that the study of chemistry leads students to think scientifically. Certainly chemistry offers a splendid chance to teach scientific methods in problem solving, but we would all agree that the mere study of the facts and theories of chemistry and a recital of its accomplishments does very little in that direction. If we want our students to be able to use the methods learned in chemistry in solving the problems of their professions we must teach them to think scientifically and to apply scientific methods whenever possible. This is the most difficult part of teaching chemistry; it is also one of the very important parts.

Individual and Group Biology Projects*

HARLEY J. VANCLEAVE

University of Illinois Urbana, Illinois

As we look back on the subject matter taught in the earliest days of science instruction we might well question whether the content of such courses really qualified as science. What we are now accustomed to refer to as the natural sciences in the early days of American education commonly went under the name of Natural Philosophy. Even as late as the beginning of the nineteenth century books were the chief formal source of knowledge to the general student. In books dealing with the history of science attention is very frequently directed to the deplorable condition of the Dark Ages when men worshipfully sought the written opinion of an ancient authority as the basis for formulating their biased judgements. In these same histories we are led to believe that the philosophy of Francis Bacon in the seventeenth century so very profoundly changed the attitude of the world toward learning that individual observation and experimentation entirely replaced the old criterion of authority as the basis of all knowledge. Still we find at the beginning of the nineteenth century in America the chief instructional works in natural history were patterned after such books as Paley's Natural Theology (1814).

It is like reviewing ancient history for me to recall that in this country the so-called scientific method never became established as a means of instruction until Louis Agassiz introduced it in his instruction at Harvard College. It is less than ninety years since Agassiz was introduced as a mighty influence on American education. Yet in that relatively short time the inflations and depressions which have assailed the social and economic fabric of our nation have played wantonly with our methods of instruction. At first rejected as unworthy of recognition in the educational scheme the laboratory method under the forceful generalship of Agassiz and other proponents rose first to mere recognition as a permissible method of instruction. During the past generation this bare acceptance grew until practically the whole field of education and instruction was becoming obsessed with aspirations to become recognized within the pale of the sciences. Even in those fields whose content precluded the claim to kinship with the sciences the popularity and promise of the objective method led to the adoption of the so-called scientific method in research and instruction. Science became a word with which to conjure, a term under whose magic spell chaotic facts became regimented as evidences supporting theories and ultimately assumed the convincing proportion to be recognized as natural laws.

Honest teachers of biology at all levels are looking for means of making their work more alive and more interesting to the pupil. Too often these efforts place burdens on the time and energy of the teacher. On the other hand commercial firms are flooding the market with substitutes for the "messy" and unsatisfactory work of the average laboratory student. I once heard a teacher state that she felt such great satisfaction over the results of the study of a huge plaster model of Paramecium. She stated that there was not the indefiniteness that always used to bother the students when they attempted to muddle through a study of living Paramecium. Unfortunately she concluded her enumeration of the advantages with the statement that besides it was no longer necessary to mess around with cultures and to attempt to teach clumsy fingers how to move a slide so as to follow the living Paramecium under the microscope. I am wondering if just

*Paper given before the Ill. Biol. Teachers' Assn., Nov. 23, 1934.

there does not lie the real difference between good and poor material for laboratory instruction. I am not at all certain but that a few fleeting glances of a moving single-celled animal with an occasional glimpse of the rhythmically beating cilia may not be worth more to the student unfamiliar with the unknown world of microscopic organisms than a detailed knowledge of the anatomy of a plaster model. Too often the teacher has attempted to fit into the high school course materials not at all suited to and even less needed by the pupil.

Often the charge is made that biology laboratories are morgues when they should be dealing with life. Ideally a laboratory should at all times have well-cared-for living material to stimulate the interest of the children in life and in living things. Time should be available in the laboratory for the study of living creatures rather than use them solely as decorative motifs. Even to the teacher who makes use of laboratory study to the full of its possibilities there are some aspects of study which are not easily undertaken by the entire class. I refer particularly to out-of-doors excursions. Many teachers even in the largest cities find it possible to keep up interest of keen students and to stimulate the curiosity of the less interested by periodic excursions out of doors to observe living animals. The reactions of teachers to such field trips are very far from uniform. Some have difficulties because of lack of ability to keep the group together. For these the problem is chiefly one of discipline. Many have the embarrassing experience of numerous questions which the teacher is unable to answer. These are the ones who are insufficiently trained in their chosen science or who are afraid to honestly confess ignorance before the pupils. Neither of these difficulties is irremedial But to the teacher who is forced to give all instruction in single periods and to the one who is so unfortunately located as to have no facilities for class field trips the following suggestions of field study by individual and by group assignment is offered.

The following are examples of the types of individual and group projects for assignment to pupils in high school biology. Animals in the home as well as those in the field make desirable objects for assigned study and report back to the class.

The simplest assignments are those which involve mere observation of facts on material not readily accessible in the laboratory because of lack of natural conditions. As examples of this sort of assignment the following are suggestive outlines. Any teacher can supplement this list and expand it to meet the individual or local needs and wants.

Especially in cool, early fall days before killing frosts, such studies are pleasantly and profitably made out ot doors.

Study I. Methods of locomotion of a grasshopper (or of any other insect to be studied):
- A. The use of the individual legs
  - a. In walking
  - b. In jumping
  - c. In climbing
- B. The use of the wings
  - a. In flying
  - b. Method of folding

Study II. Observations on Spiders.
- A. In fields, gardens, or woods make sketches of different types of webs.
- B. Observe the act of spinning
  - a. Follow construction of web
  - b. Watch spiderlings spinning gossamer for "parachutes"
- C. Observe methods of capture and despatch of prey by garden spiders
  - a. Look for remains in web
  - b. Toss flies or grasshoppers into web to observe actions of spider

Study III. Location and description of crayfish burrows
- A. Where found?
- B. Nature of the chimney
- C. Dig out burrows of different size and compare size of crayfishes

Study IV. Location and reactions of crayfishes in streams

(Continued on page 18)

Principles Involved in Chemical Warfare

RAY C. SOLIDAY

Oak Park and River Forest Township High School Oak Park, Illinois

Every chemistry teacher has undoubtedly noticed the intense interest manifested by almost every high school student whenever the subject of chemical warfare is mentioned. Much of this interest is probably due to the constant barrage of pseudo-scientific, sales-promoting stories in our Sunday supplements and other sensational publications. The high school youth has a natural interest in the mysterious and incredible. He is fascinated at the thought of the perfect war-gas, a few spoonfuls of which will completely anaesthetize a whole city, possibly dissuading the entire population from waging war on the country possessing this remarkable chemical!

Chemistry teachers have an opportunity to make a distinct contribution toward scientific thinking by calling attention of interested students to the scientific principles which apply in chemical warfare just as they do in the more prosaic mechanical refrigerator or in the killing of bedbugs. When some student comes in on Monday morning with the latest edition of the super-gas story, might it not be worthwhile to help this student analyze the scientific basis for such a tale?

In chemical warfare the several sciences are very closely interrelated. Economic problems are also involved. It is almost impossible to discuss any one phase of the subject as belonging to chemistry alone. Military experts of today are well aware of the role of scientific and economic forces in any struggle between nations. During the last war vast armed forces were helplessly intrenched, waiting for equipment which industry was unable to provide. Plans for future defense place greater dependence upon scientific achievement and industrial and economic mobilization.

The Chemical Warfare Officer of today is being trained in the basic sciences and in business administration, as well as in military science and tactics. Perhaps we in secondary schools should also recognize and teach the fundamental relationships essential to success in many activities.

What are the essentials for success in chemical warfare? This question may be answered in two words, **knowledge** and **materials.** These of course include both scientific and economic achievements.

We must have knowledge and understanding of the chemical and physical properties upon which the uses of chemical warfare agents and defensive methods depend. We must understand the physiological and medical principles involved in the poisonous or irritating actions of these agents. We must realize that every chemical agent is useful because of its activity, and that it is therefore susceptible of neutralization by some method or other. The behavior of a gaseous chemical is greatly affected by weather conditions of temperature, humidity, barometric pressure, and wind, so we must be well versed in the science of meteorology, able to predict the weather conditions for some time in the future. We must be able to devise schemes for using chemicals under adverse weather conditions when the enemy will not expect us to use them. Agents are sometimes released in gas clouds, to be carried to the enemy by gentle winds. It is obviously important to know that the wind will blow in the right direction. The volatility, the attainable concentrations, and the persistency are all dependent upon the weather as well as upon the physical constants of the chemical itself, so I repeat that knowledge of meteorology is of tremendous importance. We must have the information necessary to enable us to manufacture the desired chemicals

quickly and cheaply from available raw materials. We must be able to analyze unknown gases used against us in the field, so that proper defensive measures may be quickly applied. All in all, the successful nation must have more knowledge than the enemy.

We must have raw material within our borders in such abundance that we may cheaply and quickly produce the items required for defensive and offensive purposes. Equally essential are the industrial manufacturing facilities with which to transform these raw materials into the desired form. These facilities include not only machinery and buildings, but also labor and capital and management and scientific control. Among the raw materials which seem most essential are sodium chloride, sulfur, arsenic, limestone, bromine, charcoal, rubber, and fuels. Any country lacking many of these materials and adequate knowledge about using them cannot hope to successfully defend itself against a country having these powerful weapons.

What are the requisites for a successful chemical warfare agent? There are at least seven absolute requirements for a chemical of value in warfare, which I should mention. First, it must be very toxic, or very irritant, or produce a large volume of smoke, or have incendiary properties. We use different chemicals for various purposes in warfare, each possibly equally important. Not all are poisonous gases. White phosphorus, for example, is used to produce smoke and also for incendiary purposes. Second, it must be stable in storage and reasonably stable in contact with moisture. Most chemical agents must be stored for considerable periods of time after manufacture. They must not deteriorate. The famous Lewisite, beta-chlorvinyldichlorarsine, is not now regarded as highly as formerly. We have learned that Lewisite reacts quite rapidly with water. Third, it must be capable of manufacture on a large scale. Here again Lewisite is not as satisfactory as some other agents. Fourth, raw materials must be available within the home country. It is obviously poor policy to plan on securing war materials from across the sea. Fifth, it must be suitable for loading in munitions, and be rather non-corrosive on ordinary steel. Here our well-known carbon monoxide becomes unsatisfactory, having a critical condensation temperature of -139 C., which means too high a pressure in the bomb or shell at ordinary temperatures. Hydrogen cyanide is also unsatisfactory in this requirement. Sixth, it must be capable of vaporization or other means of dissemination in sufficient concentrations under field conditions to produce the desired effect. This differs tremendously for different agents. One part in a million parts of air is sufficient concentration of chloracetophenone to be intolerable, while much greater concentrations are required for lethal results by the toxic agents. Seventh, if a gas under ordinary conditions, it must be easily compressed to a liquid and easily vaporized when the pressure is released.

It is easily seen that these seven requirements impose tremendous restrictions upon the list of usable chemical warfare agents. From the many thousands of chemicals which have been actually investigated, only a scant dozen have proven satisfactory for use in warfare. Only three new agents have been developed since the war. Of the thirty-six used during the war, all but twelve have been discarded. The three poisonous gases familiar to every high school chemistry student, carbon monoxide, hydrogen sulfide, and hydrogen cyanide, have not been used successfully in war, although hydrogen cyanide is about thirty times as toxic as chlorine.

Perhaps our protective equipment and planning best illustrate the importance of scientific knowledge. We have two types of protective equipment—that for individual use, and that for collective protection. The gas mask is the best known of the individual protective devices. It utilizes several principles of interest to the student of physics or chemistry. Our present canister filling consists of a mixture of granular charcoal with soda-lime and potassium per-

(Continued on page 22)

Chic-Embryo Biology Project

H. L. SLICHENMYER

Bloomington High School Bloomington, Illinois

The study of embryology in the high school biology course seems most uninteresting to the average high school pupil if theory only is studied, but practical embryology along with the theory seems to arouse considerable interest in most pupils. Some pupils are interested in making projects. A project in embryology is one that may be prepared by some high school pupils with very little help from the instructor.

Although I have never had much faith in exhibits, a project on the "Chick Embryo" prepared by two Bloomington High School pupils, was exhibited at the Junior Academy of Science meeting held at Quincy, Illinois last spring.

The two boys, Fred Muxfeld and Robert Lorenz, became interested in the subject of embryology after examining a commercial exhibit, "The Embryology of the Pig," which we have in the laboratory. They suggested making a project. "Development of Squash Seedling," and similar topics were suggested but they preferred to study the embryology of some animal. Finally the "Chick Embryo" was selected. They read what references they could find in the Public Library, and in the libraries of Illinois Wesleyan university and Illinois State Normal University. They also used "Turtox Service Leaflet No. 43, Embryology in the High School Biology Course".

After collecting all available information, the boys purchased some fertile eggs, and took them to a hatchery which was very willing to cooperate with them. Much less difficulty was experienced in this work than was anticipated. Only three eggs more than were necessary were used in preparing the project.

In studying the egg before and after incubation the following procedure was followed.

The shell was cracked and the contents was allowed to flow into a bowl containing a normal sodium chloride solution. The eggs which had been incubated were placed in a solution heated to the same temperature as that of the incubator. This work was done in the hatchery. In communities where a hatchery is not available a good sitting hen would serve the purpose. The sitting hen method would be an even better method for larger communities as it would permit the pupil to see how nature has provided for the incubation of the eggs.

The instruments used were: Scalpel, teasing needles, forceps, scissors, thermometer, and Bunsen burners.

The following stages were studied: unincubated egg—shell, membranes protecting the egg, food material, and the blastodisc were seen; after 2 days incubation—heart was seen; after 4 days incubation—a small chick form was seen, After that time the embryo chick showed noticeable development at each observation. Also each observation showed less food left in the egg. Observations were then made on the 6th, 9th, 12th, 18th, and 21st days.

Any of the usual preservatives might have been used. The boys preferred to use a solution of alcohol. After the embryos at the various stages had been collected, they were placed on black backgrounds which fitted into two specimen jars, each 3 inches in diameter and 8 inches in height. If one specimen jar had been large enough to contain all embryos, the result would have been a better looking exhibit and a truer view of the embryos.

Not only did the boys who carried on the work gain a great deal from this project, but all the pupils who were studying biology were interested in the progress being made by the boys, and demanded a report each day.

Practical Science Projects

For teaching science principles, creating intense interest, solving those problem cases and providing club activity

SEARCH NO FURTHER through text books, recipe books and plans for doing things that may not even work.

The projects listed are the outgrowth of successful project work by science students, and are selected because of their value in teaching and their popularity with students.

WORRY NO MORE about information for carrying out a project. Complete information for carrying out the projects is given, together with some discussion of the application and value.

The following projects are taken from teachers' work sheets and are published in mimeograph form in groups of five.

BIOLOGY—Group 1

By John Ayres, Community High School, Normal, Illinois

A Vitamin Project, Practical for High School Students
An Artificial Stomach—Explains Digestion
Observing Heredity with the Drosophila Fly
Examination of Bacteria in the Milk Supply
Analyzing the Water Supply for Bacteria

Group 1A

Mold Cultured Cheese
Cheddor Cheese
Field Study of Birds
Mounting Birds
Embryos of Fish, Birds, and Mammals

PHYSICS AND GENERAL SCIENCE

Group 2

By C. L. Beier, Community High School, Normal, Illinois

Rotator—for Stroboscope effect, color discs, etc.
Stroboscope
Microprojector, for small groups
Simple type A. C. Motor
Powerful Electro Lifting Magnet

Group 2A

D. C. Motor, Simple Type
Color Box
Three Way Switch
Huygen's Principle Tank
Crovis Disc for Sound

CHEMISTRY PROJECTS

By the following authors—
M. E. WOODWORTH, Pittsfield High School, Pittsfield, Illinois
S. A. McEVOY, Rockford High School, Rockford, Illinois
WILLIS T. MAAS, Dupo High School, Dupo, Illinois
JOHN C. CHIDDIX, Community High School, Normal, Illinois

Group 3

Testing Lubricating Oil
Hydrogenation of Vegetable Oils
Getting Sugar from Corn
Rayon—Synthetic Fibers
Photography

Group 4

Making Paint
Making Plastic Wood
Making Bakelite
Making Lime
Making Polish—Wax type

Group 5

Mirror Making
Electroplating
Obtaining and Using Casein from Milk
Making Ink
Tanning Leather

Group 6

Crystal Growing
Making Models of Mineral Crystals
Clay Modeling
Etching Designs and Photographs on Metal
Fur Tanning

Group 7

Making Baking Powder
Dyeing Cloth
Making Vanishing Cream
Making Cold Cream
Preservation of Food

Each group 25c; three or more groups, 20c each

THE SCIENCE TEACHER
201 North School Street, Normal, Illinois.

National Geographic School Service

McFall Kerby, Chief

The School Service of the National Geographic Society, a source of information for teachers and students, is one of the Society's means for carrying out the purposes for which it was founded in 1888, "the increase and diffusion of geographic knowledge". As the Society grew in influence and ability to send its writers and expeditions into various parts of the world, teachers and students began addressing inquiries to its Washington headquarters, seeking the fresher geographic information that was thus brought to light—information that could not find its way quickly into textbooks and reference books. Because of the growing number of these inquiries it became necessary in 1916 for the Society to establish a separate department in order adequately to answer them. The Service has expanded as it has been called upon to meet developing needs.

In 1919 the School Service began the publication of a weekly illustrated pamphlet, the GEOGRAPHIC NEWS BULLETINS, designed to supplement geography, history, and civics textbooks and to deal particularly with countries, areas, industries, commodities, and scientific developments upon which world interest is centered at the moment. The world's newspapers, recording rapidly occurring events, are constantly furnishing the raw materials for geography, history, political science, and the natural sciences. The News Bulletins seek to make this material more significant for teachers and students by providing a background of facts and photographs. They tell, in regard to the locale of important happenings, the kind of people, the type of country, the resources, the industries, the traditions, the customs, the governmental and economic machinery, and the other factors involved.

This little magazine is published weekly for 30 weeks during the school year, and each year it has reached an increasing circle of school rooms. The Bulletins are now received by more than 30,000 teachers, and the material is passed on by them to several hundred thousand school children. Included in this group are teachers of biology, chemistry, history, civics, and English, as well as those in various fields of geography.

Each issue of the News Bulletins consists of five brief illustrated stories, a sufficient number so that one can be used, if desired, for each school day of the week. In the pages of the Bulletins appear, among the items that help to keep geography and its allied subjects up-to-date, news of changed boundaries and governments, the results of explorations, the construction of new railways and highways, the establishment of new airlines, the development of new industries, etc. One of the features of the Bulletins is the publication with each story of references to articles, maps, and photographs dealing more fully with the same subjects, which have appeared in recent years in the **National Geographic Magazine.** This facilitates the preparation of class reports, themes, discussions, and debates in projects or units of study. It also supplies illustrative material and thus helps in the working out of sand table, bulletin board, note book, and other projects in connection with visual education work.

As a further aid to visual education, the School Service has obtained unbound prints of many of the superb natural-color sections of the **National Geographic Magazine** for use in school rooms and school libraries. When these back issues are sold for other than educational purposes, the cost is many times that fixed by the School Service.

The SchoolService maintains a group of research assistants in order to answer the many questions which reach it by mail from teachers and students. During 1936 more than 20,000 inquiries of this character reached the Service and received individual answers.

This article was written by request. Those interested should write to the author of the article c|o National Geographic Society, Washington D. C.

Illinois Biology Curriculum Program

The curriculum committee announced in the last issue of THE SCIENCE TEACHER held its first meeting at the University of Illinois on March 6th with Mr. A. W. Clevenger, High School Visitor and Mr. F. C. Hood, Assistant High School Visitor. Mrs. Grace I. Cook, Champaign, President of the Illinois Biology Teachers Association was added to the committee at the request of Mr. Clevenger. The meeting lasted all day and all members of the committee were present except Mr. W. W. Minear of Quincy.

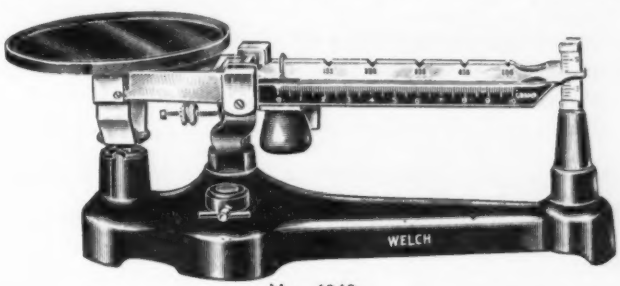
Mr. M. C. Lichtenwalter, Lane Tech, Chicago was selected chairman and Miss Opal Hartline, Normal University was selected Secretary-Editor. After considerable discussion the committee chose seven subjects for the work of the committee. For each of these subjects there was appointed a sub-committee of two or three members. These sub-committees will be enlarged by the addition of teachers not on the original committee.

The subjects chosen and the sub-committees appointed are as follows:

1. Aims and Objectives for The Teaching of Biology.
   Mrs. Olive Nuttall, Springfield
   Mr. W. W. Minear, Quincy
2. Minimum Essentials for the Biology Course.
   Mr. P. K. Houdek, Robinson
   Mrs. Olive Nuttall
3. The Training of the Biology Teacher
   Mr. W. M. Bailey, Carbondale (Normal)
   Miss Opal Hartline, Normal (Normal)
4. Vocational Guidance and Practical Aspects of Biology
   Miss Grace L. Cook
   Mr. Louis Astell, Urbana (University High)
5. Care and Use of Equipment,

(Continued on page 21)

THE WELCH TRIPLE-BEAM TRIP BALANCE



No. 4040

This Balance has Three Times the Beam Capacity of Double Beam Trip Scales

SPECIFICATIONS:

Front beam weighs from 0-10 grams by 0.1 grams
Center beam weighs from 0-500 grams by 100 grams.
Third beam weighs from 0-100 grams by 10 grams.
Total capacity on beams 610 grams.
Total capacity with extra weight 1,110 grams.
Honed knife edges rest on agate planes.
Pan made of molded Bakelite.

NO. 4040 TRIPLE BEAM BALANCE

Harvard Trip Scale construction. Complete with sliding weights on beams. Each $12.00
NO. 4040W—Extra weight to increase capacity to 1,110 grams ..... .75

W. M. WELCH SCIENTIFIC COMPANY
Established 1880
1515 Sedgwick Street, Chicago, Illinois, U. S. A.

ORGANIC CHEMISTRY

(Continued from page 3)

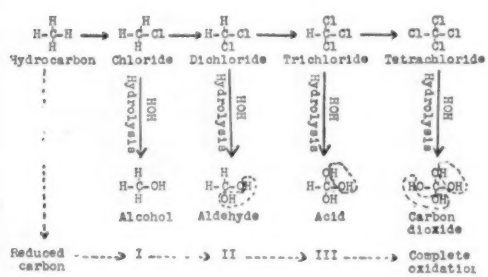
b. Hydrocarbons of petroleum:
   (1) Petroleum—a mixture of hydrocarbons.
   (2) Importance of the petroleum industry in the United States.
   (3) Distillation of petroleum—gasoline, kerosene, fuel oil, lubricating oils.
   (4) "Cracking" of heavy fractions: Making compounds of low boiling points by breaking the larger molecules into smaller ones.
   (5) Blending of gasoline with "natural", "straight", and "cracked". "Ethyl gasoline".
   (6) A few pure hydrocarbons have been isolated from petroleum. Besides pentane, also hexane— $CH_3CH_2CH_2CH_2CH_2CH_3$. It is possible for the two end carbon atoms to unite forming a ring structure called cyclohexane.

c. **Saturated hydrocarbons.** All the above hydrocarbons have the four valences of carbon satisfied and are called **saturated.**
   (1) **Reactions:**
      (a) Inert to ordinary chemical reagents (room temperature): H_2SO_4, Br_2, Cl_2, etc.
      (b) With rising temperature, reaction occurs. Methane is burned or oxidized:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2HOH + \text{Heat}$$

reduced carbon — oxidized carbon

      (c) **Stages of exodiation:** Similarly, methane can react with chlorine:



The above serves as the basis of the classification of the important groups of carbon compounds. Methane possesses energy; in the same manner each of the compounds of groups I, II and III gives less heat of combustion than the preceding group. From this standpoint, then, hydrocarbons can be made to react, and certain of their uses are brought out.

The unsaturated hydrocarbons first introduced in the discussion of "cracking" can now be taken up through a study of ethylene and acetylene. Their reactivity and uses are stressed.

d. **Unsaturated hydrocarbons:**
   (1) In the gases obtained in "cracking" a hydrocarbon, ethylene, C_2H_4 is obtained.
   (2) Relation of ethylene to ethane: $C_2H_4 + H_2 \rightarrow C_2H_6$
   (3) It reacts with chlorine, bromine, etc. $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$ (ethylene dichloride).
   (4) This reactivity is explained by the fact that all the valences of the carbon are not satisfied (unsaturation). It is usually represented by two dashes, = (double bond).
   (5) Acetylene is another example of unsaturated hydrocarbons. Obtained from cheap raw material, coke and limestone.
   (6) Relation of acetylene to ethane and uses because of its reactivity and ease of preparation at low cost.

Benzene can be introduced at this point through cylohexane. By removing hydrogen from cyclohexane, cyclohexene may be obtained:

$$C_6H_{12} \rightarrow C_6H_{10} + H_2$$

This is an unsaturated hydrocarbon. Elimination of more hydrogen gives benzene, C_6H_6, which, in accordance with what has been developed, should react with bromine, potassium permanganate, etc. But **it does not.** Many theories have been proposed to account for this fact. This is followed by a discussion of benzene hydrocarbons obtained from the distillation of coal:

   (7) Cyclohexene can be obtained by removing hydorgen from cyclohexane.

(Continued on page 16)

The Macmillan Company Announces the Recent Publication of a New Chemistry

Among the many modern products and developments explained in **NEW PRACTICAL CHEMISTRY** *are*

"frozen" foods
heat-tempered glass
the spectograph
heavy water
heavy hydrogen
new uses for tungsten and magnesium
new developments in water purification and in sanitation
new coal-tar products
systems for eliminating smoke-nuisance
air-conditioning systems
anti-freeze solutions
"anti-knock" remedies
"dry ice"
soapless soap

Some quick facts about the superb teaching and study equipment of the book:

Nearly 350 illustrations are used—diagrams and half-tone pictures, many of them used in this book for the first time

Summaries, key-words, laws, pre-views of chapters are set in bold-face type. Laboratory experiments are set off in a distinctive small type

Questions for study, topics for further investigation and research, bibliography, review questions, and tests follow each chapter

The product of two experienced authors and gifted teachers who are also among the most eminent scientist of our day!

NEWTON HENRY BLACK
Assistant Professor of Physics
Harvard University
Formerly Science Master, Roxbury Latin School

and

JAMES BRYANT CONANT
President of Harvard University
Formerly Professor of Chemistry

NEW PRACTICAL CHEMISTRY

A Teachers' Manual for the text and a laboratory manual for students are available

ORGANIC CHEMISTRY

(Continued from page 14)

(8) Benzene. By further removal of hydrogen, benzene may be obtained. This should be very reactive, but it is **not.** Many theories have been proposed to account for this. The work of Kekule.

e. **Benzene hydocarbons.**

(1) Many important compounds are derived from benzene.

(2) Benzene and related hydrocarbons are obtained from the distillation of coal (coal tar compounds).

(3) Distillation of coal. Coal is a complex mixture of organic compounds which on heating undergoes "cracking" and by recombination gives benzene, toluene, naphthalene and other hydrocarbons.

(4) Products of coal distillation.

With such a background, the other groups may be briefly studied. The halides derived by reaction of hydrocarbons with halogens; the alcohols obtained by hydrolysis of halides; and the amines derived by the reaction of halides with ammonia:

IV. Brief discussion of the most important groups of organic compounds.

1. **Halides.** Examples.

CH_3Cl—methyl chloride—used as a refrigerant.

C_2H_5Cl—ethyl chloride—used as skin refrigerant in local anaesthesia.

C_6H_5Cl—phenyl chloride or chlorobenzene—used for synthesis.

On hydrolysis they give alcohols:

$R\text{-}Cl + HOH \rightarrow R\text{-}OH + HCl$

2. **Alcohols.**

a. $CH_3Cl + HOH \rightarrow CH_3OH$—Methyl alcohol.

$C_2H_5Cl + HOH \rightarrow C_2H_5OH$—Ethyl alcohol.

$C_6H_5Cl + HOH \rightarrow C_6H_5OH$—Phenyl alcohol or phenol.

b. Industrial preparation of methyl alcohol from carbon monoxide.

c. Production of ethyl alcohol by fermentation of sugar. (Cracking of large molecules by enzymes).

d. Uses of alcohols as solvents. Social aspects of use of dilute and concentrated solutions of alcohol in beverages. Antiseptic properties of phenol and related compounds.

3. **Amines.**

a. $CH_3Cl + NH_3 \rightarrow CH_3NH_2$—Methyl amine

$C_2H_5Cl + NH_3 \rightarrow C_2H_5NH_2$—Ethyl amine

$C_6H_6Cl + NH_3 \rightarrow C_6H_5NH_2$—Phenyl amine or aniline

b. Importance of aniline.

If it is desired, the aldehydes and ketones can be introduced at this point. They can be derived from the hydrolysis of the dihalides:

$$CH_3Cl \rightarrow CH_2Cl_2 \text{ (hydrolysis)} \dashrightarrow CH_2(OH)_2 \rightarrow H\text{—}\overset{H}{\underset{|}{C}}\text{=O} + HOH$$

(formaldehyde)

Aldehydes and ketones are very reactive, being easily oxidized to acids, which are considered next, by a discussion of acetic acid.

4. **Acids.**

a.

$$R\text{-}C(Cl)_3 \xrightarrow{\text{Hydrolysis}} R\text{-}C(OH)_3 \longrightarrow R\text{-}\overset{H}{\underset{|}{C}}\text{=O} + HOH$$

b. Acid properties of the hydrogen of the -OH. Acetic acid as an example.

c. The long chain acids are important as they occur in oils and fats.

d. Acids react with alcohols to form esters.

e. Discussion of acetic acid.

5. **Mixed type compounds.**

a. We can have two or three -OH groups in the same molecule. The compound is still an alcohol. Examples: ethylene glycol (prestone) and glycerol (glycerine).

b. Two dissimilar groups may be present. For example:

CH_3COOH, acetic acid, and

NH_2CH_2COOH, amino acetic acid.

Or alcohol and aldehyde groups as in glucose.

A consideration of foods should conclude the unit. Although the topic of foods is too well known to need any detailed outline, a procedure which has been found useful is outlined below. Foods and fuels should be taken together

(Continued on page 20)

New Study Guides in Science

A COMBINED LABORATORY MANUAL AND WORKBOOK IN BIOLOGY by

Davis and Davis

A COMBINED LABORATORY MANUAL AND WORKBOOK IN CHEMISTRY by

Conn and Briscoe

A COMBINED LABORATORY MANUAL AND WORKBOOK IN PHYSICS by

Cook and Davis

DIRECTED STUDIES IN GENERAL SCIENCE (A Combined Workbook and Experiment Manual) by

Painter and Skewes

These books are the most attractive, helpful, and popular teacher and pupil aids in their respective fields.

Correspondence Invited

MENTZER, BUSH and COMPANY

2210 South Park Way

Chicago

BIOLOGY PROJECTS

(Continued from page 7)

A. Observe normal crawling
B. Observe when disturbed
C. Where do crayfishes come to rest?

Study V. Insect visitors of flowers
A. Observe methods of securing nectar
B. Look for pollen on insects
C. Do you find any insects on the flowers apparently not interested in nectar? Observe

The foregoing are types of relatively short observational studies involving little expenditure of time in the field and a minimum of direction on the part of the teacher. For pupils more interested and capable of extended observations and collections the following are suggestive of studies which may be expanded or modified to meet individual and local needs. Through the courtesy of Ginn and Company, these studies are taken directly from "Biological Principles in General Zoology—A Laboratory Manual," by Van Cleave, Linville, and Kelly (1930).

Study VI. Aquatic insects and their adaptions
A. Select a pond or stream for study. Look for water striders and other insects that live on the surface of the water. What are some of their peculiarities that enable them to live on the water but not in it?
B. Observe beetles and bugs swimming in water. Do you find any modification of the legs to better enable them to swim?
C. When some of these free swimmers come to the surface, watch to see what takes place. Where do they get their air for breathing while they are under water?
D. In mud and under sticks, stones, and leaves look for larvae and nymphs of different insects.
E. Where do you find the ones with much-flattened bodies? Why?
F. Look for pebbles and sand grains held in clumps on the under surface of stones. Pull some of these cases apart to find larvae.
G. What insects do you find flying low over the water?
H. Many kinds of aquatic insects are not mentioned here, but they should be observed and reported upon when found.
I. A few specimens of each kind should be taken to the laboratory for study and recognition.

Study VII. Insect life of a rotten log or stump
A. Examine for insect life a rotten log lying flat on the ground.
B. Pry off pieces of the loose bark. Various small or flattened insects may be located between the bark and the wood. Ants, beetles, beetle larvae, "white ant," roaches, bugs, cocoons of moths, are among the commonest insects to be found, and centipeds, millipeds, salamanders, pill bugs, small snails, spiders, and other animals are frequently found.
C. If the wood is soft enough to be dug away with a knifeblade, look for beetles, grubs, ants, and various other insects in tunnels.
D. Collect a few specimens of all possible kinds in vials or small bottles and take to the laboratory for further study.

Study VIII. Hibernating insects . . . .
After the weather has become cool and most of the leaves have fallen from the trees, there are but few active insects to be found, though some remain active on bright days throughout the winter. Some pass the winter as adults, crawling into crevices, beneath bark or under leaves for protection; others are represented over winter by inactive pupa stage only, and still others pass the winter as eggs or immature larvae or nymphs.
A. Hunt for inactive, hibernating insects in small piles of rubbish

or leaves on lawns or in gardens.

B. Examine branches of trees, shrubs, and hedges for cocoons of moths These may frequently be found on the sides of houses and under boards and stones.

C. Crevices in bark and around the bases of trees are favorable places to find hibernating adults and young.

D. Look for wintering egg masses on cocoons of tussock moths attached to branches of trees or to the sides of buildings.

E. Examine nuts and acorns for "worms" the larvae of beetles.

F. Make a list of the different kinds of insects that you find, indicating for each the place where you found it and the stage in which it hibernated.

G. Read "How Butterflies Pass the Winter," **Nature Magazine** for February, 1924 (Vol. III, No. 2), p. 223.

Studies of which the foregoing are types may be carried on individually or by groups of pupils. In the latter instance it is usually desirable that one pupil be assigned by the teacher or selected by the group as responsible for the organization of the project. The captain of the project may then allot particular portions of the study to members of the group for close observation.

The writer has no intention of advocating the assignment of individual and group projects for study outside the school room as a complete substitute for well-organized laboratory exercises in biological classes. However, work of this sort does offer the opportunity of enlisting the interest and active participation of pupils in the study of living animals and plants under conditions of nature. The teacher who uses it wisely will find new points of contact with and increased understanding of the pupils. From point of view of the pupil he may gain a clearer concept of some of the principles of Biology as a Science of Life.

For Insuring Straight Thinking In Science

Caldwell and Curtis: SCIENCE FOR TODAY

Curtis, Caldwell, and Sherman: BIOLOGY FOR TODAY

An integrated program consisting of texts, workbooks, and tests—built on the program-unit plan—content determined scientifically—special attention to vocabulary—modern—up to date—teachable—may be used as a series or independently.

Millikan, Gale, and Coyle: NEW ELEMENTARY PHYSICS

Accurate—up to date—interesting—teachable—provision for individual differences—unit organization.

For further information about these books, write

GINN AND COMPANY

2301-2311 Prairie Avenue **Chicago**

Chemistry and Biology Tests . . .

Tests are fundamental teaching aids. Are **you** using them? We offer:
Rich Chemistry Tests. Sample set 20c.
Persing Laboratory Chemistry Test. Sample set 15c.
Malin Test in Mechanics of High School Chemistry. Sample set 15c.
Cooprider Biology Test. Sample set 10c.

Quantity prices on request.

Yearbook On Science . . .

Have you read "A PROGRAM FOR TEACHING SCIENCE," published as Part I of the Thirty-First Yearbook of the National Society for the Study of Education? It is unquestionably a highly significant contribution to the field of science education.

Prices: $1.75 for paper covered edition; $2.50 for cloth covered edition, postpaid.

PUBLIC SCHOOL PUBLISHING COMPANY
Bloomington, Illinois

ORGANIC CHEMISTRY

(Continued from page 16)

We can start with methane as a fuel.

V. Fuels and foods.

1. Fuels and foods contain chemical potential energy.
2. Among the most important fuels are natural gas, petroleum, coal, all mixtures of compounds of carbon. In burning, the carbon and hydrogen become oxidized and the chemical energy is transformed into **heat.**

   For example, recall:
   $CH_4 + 2O_2 \rightarrow CO_2 + 2HOH + Heat$
   The reverse of this is reduction. This reduction of carbon is actually the principle involved in **photosynthesis.**

In plants: Sunlight (radiant energy) $+ CO_2 +$ HOH $\xrightarrow{\text{chlorophyll}}$ $(H\text{-}C{=}O) \rightarrow C_6H_{12}O_6 + O_2$ (H enzymes)

In animals: Organic compounds $+ O_2 \rightarrow CO_2 + HOH + Heat$

3. **Discussion of fuels.** Similar to the outline given in any text.
4. **Foods.**
   a. Besides water and salts, mixtures of organic compounds are required by the animal organism for sustaining life. These can be divided into four groups:
   (1) Carbohydrates $\rightleftharpoons$ (digestive hydrolysis) simple sugars
   (2) Fats $\rightleftharpoons$ (digestive hydrolysis) glycerine and long chain acids
   (3) Proteins $\rightleftharpoons$ (digestive hydrolysis) amino acids
   (4) Vitamins—complex compounds. Small amount necessary for the proper function of the body.
   b. Selection, preparation and preservation of foods. The role of the chemist.

If time permits, the instructor can select a number of interesting topics for presentation. A few are suggested: soaps, sugars, vitamins, brief survey of metabolism, application of organic chemistry to industry, etc.

(Continued in next issue)

OBJECTIVES IN TEACHING BIOLOGY

M. C. Lichtenwalter

(Continued from last issue)

The Relationship of Planimals

To know that living things are dependent upon each other.

To know that man is dependent upon living things.

To acquire a knowledge which will produce a better understanding of the environment.

To know life zones.

To develop the ability to understand ecological relationships.

To know the importance of natural barriers.

To develop an attitude of appreciation for nature.

Economic Importance of Living Things

To know how to control pests and injurious insects.

To know what animals carry diseases.

To know obnoxious plants.

To develop an appreciation for the conservation of life.

To know the economic importance of forests; of groups of animals and plants; of living things as food for man; of bacteria as the cause of disease.

Vocational and Avocational Aspects of Biology.

To develop an interest in the work of the Government in conservation.

To know our duty toward the conservation of biological resources.

To acquire wholesome interests of a biological nature for spare time.

To explore the various fields of interest with the intent of developing new interests, capacities, and abilities.

To develop an appreciation of the various fields of biology as possible vocations.

General List

To understand the significance of life.

To develop attitudes of appreciation for nature.

To develop an attitude of one's responsibility to the world.

(Continued on page 24)

High School Chemistry

Revised

By George Howard Bruce

A text for a sound, practical year of modern chemistry. The simplicity of presentation, the clearness with which difficult topics are developed, and the attention devoted to instructional details are features of the book. The author is an experienced and efficient teacher who knows how to organize the course for greatest ease of instruction and who can write so the average student will understand.

Write for information

World Book Company

2126 Prairie Avenue, Chicago

CHEMICAL WARFARE

(Continued from page 9)

manganate. A felted filter is also provided to remove the irritant smokes. The charcoal, from selected sources such as cocoanut shells, is our most effective adsorbent material, having the peculiar property of condensing and holding gaseous substances in thin films upon the surface of the pores of the charcoal. The very best activated charcoal will reduce a concentration of 7,000 parts chlorpicrin per million parts of air to less than 0.5 parts per million in less than 0.03 second. The soda-lime acts as a reservoir of large capacity for the permanent fixation of the more volatile acid and oxidizable gases. This combination now used gives a very uniform action under changes of temperature and humidity. This mixture does not absorb carbon monoxide or ammonia, and is therefore valueless against these gases. It is of little use in an atmosphere deficient in oxygen. We do have another canister filling, called Hopcalite, which protects against carbon monoxide by converting it catalytically into the dioxide. This material is a mixture, 50 per cent manganese dioxide, 30 per cent copper oxide, 15 per cent cobaltic oxide, and 5 per cent silver oxide. Although we do not expect to use this canister filling in war, it is of great value in mine rescue work.

It should be emphasized that nearly all known chemical warfare agents may be rather readily neutralized or absorbed by common, abundant, cheap chemicals. Among these useful defensive materials should be mentioned gasoline, kerosene, hot soap suds, boric acid, steam, chlorine, chloride of lime, copper sulfate solution, sodium hydroxide solution, linseed oil, baking soda, and washing soda. We understand fairly well the actions by which these protective agents are valuable. Gasoline and kerosene may be used to sponge off mustard and Lewisite from the skin or equipment. Boric acid protects the eyes from tear gas. Chlorine and chloride of lime chlorinate mustard, and most other agents. Copper sulfate solution stops white phosphorus burning, converting the phosphorus into copper phosphide. 5 per cent sodium hydroxide solution destroys Lewisite almost instantly. Boiled linseed oil applied to the outer surface fo clothing affords good protection against mustard. Plain water reacts with many agents, producing less dangerous products by hydrolysis. Lewisite is readily destroyed in the field by rain. On the other hand, we have learned that since mustard is readily soluble in hydrocarbons we must not expect to protect ourselves by rubberizing our clothing. It seems reasonable to suppose that any defensive army of our country will always have an adequate supply of these common protective materials. Knowledge of the use of each is all-important.

Group protection includes the use of gas-proof shelters, protection of food, water, and equipment, and the decontamination of ground areas and equipment by chemical means. These alike depend upon chemical and physical properties of the materials used. Gas-proof shelters protect due to the elimination of drafts into the shelter. Our modern air-conditioning developments seem to lead to adequate protection for civilian populations in our cities. It should be possible to filter the incoming air through an adequate canister, and to prevent gas leakage at windows and doors by maintaining a slightly higher air pressure within the building. Fire departments may be equipped with protective clothing and with chemicals for destroying chemical warfare agents in the streets.

In conclusion, it should again be pointed out that the use of chemical agents in warfare involves applications of scientific and economic principles which are fairly well understood. These applications are also of considerable importance in peace time control of civil disturbances. A moderate amount of emphasis placed upon an understanding of these principles will go far toward dispelling the fog of mystery now enveloping this subject. Students are interested and anxious to learn. There are several good articles and books

(Continued on page 24)

★ The Wilson Books

In Combined Volume

DESCRIPTIVE CHEMISTRY and DESCRIPTIVE PHYSICS

BY

Sherman R. Wilson of Detroit, are now available either as separate volumes or in a less expensive combined form.

This one-year, non-technical course for "general" students has aroused widespread and immediate interest. Practical and easily organized, it meets a pressing need in the modern high school.

For brochure discussing objectives, organization, psychology, etc., of this new course, or for sample copy, please write.

Descriptive Chemistry $1.20 list
Descriptive Physics $1.20 list
} Combined Volume $1.80 list

★ Other Outstanding Science Textbooks

Dull: Modern Chemistry (1936 Ed.)
Dull: Chemistry Workbook
Dull: Tests in Chemistry, Series II
Howard: Units in Chemistry
Howard: Laboratory Manual and Workbook
Dull: Modern Physics
Dull: Physics Workbook
Dull: Tests in Physics, Series II
Davis and Sharpe: Science
Davis: Directed Study Guide and Manual
Moon and Mann: Biology for Beginners
Moon, Thayer, and West: Laboratory Manual
Weymouth: A Guide and Workbook in Biology
Weymouth: Instructional Tests
Thackston and Thackston: Human Health

HENRY HOLT & COMPANY, Inc.

2626 Prairie Avenue,
Chicago, Illinois

CHEMICAL WARFARE

(Continued from page 22)

available for independent reading and study. It is suggested that a brief study of this topic will provide an interesting and worthwhile unit for the high school chemistry course.

Bibliography

1. Slosson, E. E.: Creative Chemistry. Century. 1919.
2. Darrow, Floyd L.: The Story of Chemistry. Bobbs-Merrill. 1927.
3. Riegel, E. R.: Industrial Chemistry. Chemical Catalog Co. 1933.
4. LeFebure, Victor: Riddle of The Rhine. Chemical Foundation. 1925.
5. Holmes, Harry N.: Out of the Test Tube. Emerson Books. 1935.
6. Journal of Chemical Education
October, 1929. p. 1697—
December, 1929. p. 2147—
January, 1930. p. 95—

Some War Gases

1. Chlorine Cl_2
2. Phosgene $COCl_2$
3. Diphosgene $ClCOOCCl_3$
4. Chlorpicrin CCl_3NO_2

OBJECTIVES IN BIOLOGY

(Continued from page 21)

To recognize the fact that man is a living thing with similar problems to solve.

To know food requirements.

To know the history of biology.

To know the biographies of important biologists.

To know the kinds of food needed by the human body.

BIOLOGY CURRICULUM

(Continued from page 13)

Laboratory Atmosphere
Miss Ruth O. Spencer, Moline
Mrs. Grace L. Cook

6. Social Hygiene and Sex Education
Mr. Wesley Heinz, Mendota
Mr. P. K. Houdek
Mr. Louis Astell

7. Specific Suggestions for Improvement of Instruction
Mr. Louis Astell
Mr. W. W. Minear

Complete Equipment

— *for the* —

CHEMISTRY and BIOLOGY LABORATORIES

PROMPT DELIVERY AND QUALITY CHEMICALS

Chemical Laboratory Supplies - - - Biological Materials

Including Preserved Specimens, Museum Preparations, Prepared Micro Slides, Charts and Models.

JOHN J. MINER, ***Representative in Illinois***

Chicago Apparatus Company

1735 - 43 N. Ashland Avenue CHICAGO

WHY have 5,618 schools changed to this new laboratory manual?

Chemistry Guide and Laboratory Exercises

with Accompanying Tests

BY

M. V. McGILL
Lorain High School, Lorain, Ohio

G. M. BRADBURY
Montclair High School, Montclair, New Jersey

The Journal of Chemical Education says: "It is full of interest-getting devices. The **Guide** is valuable to both pupil and teacher. The wide use of the previous edition forecasts an even more extended use of the improved volume. It should be carefully considered by all teachers of introductory chemistry."

a new approach to chemistry

Five essential features are incorporated in this Chemistry Guide: (1) a logical experimental method; (2) closer correlation between laboratory and classroom work; (3) mastery unit organization; (4) continuous student guidance through the ways and means of chemistry; (5) pointed emphasis on chemical principles and their application to practical situations.

for use with any text

Its standard material supplements equally well the book you are using in the present school year or any current textbook you may be planning to adopt.

CONTENTS

Unit		Unit		Unit		Unit	
I	The World	V	Ions	IX	Nitrogen Family	XIII	Metallurgy
II	The Air	VI	Equations	X	Colloids	XIV	Useful Compounds
III	Water	VII	Sulfur	XI	Carbon	XV	Iron and Aluminum
IV	Formulas	VIII	Halogens	XII	Organic Chemistry	XVI	Other Metals

four important programs in one book

A study guide, a laboratory manual, a review program, and, (under separate cover) a free testing program, this "pupils road map to chemistry" covers the suggestions made by 1500 chemistry instructors and administrators.

testing program furnished free of charge

A separate booklet of objective chemistry tests provides an entire testing program for one school year.

PUBLISHED BY

LYONS and CARNAHAN

2500 Prairie Avenue **Chicago, Illinois**

The Finest of MERCURIAL BAROMETERS

Substantial

Durable

Accurate

DURABILITY—a long life of dependable accuracy—is provided by the ruggedly-constructed adjustable mercury well. This patented feature—found only on Cenco barometers—consists of a heavy molded glass reservoir operating in a housing of molded bakelite. This construction eliminates the insubstantial, leaky chamois leather bag—the cause of failure of the Fortin type of barometer. In addition, it promotes accuracy of setting of the base index to the lower mercury level, because of the clear vision and adequate entrance of outside light.

The Cenco Mercurial Barometer stays new for a greater period of time, because the oxidized brass protecting tube and special metal scales and verniers do not corrode. These materials cost more—but not much more—than other less durable materials, but their use makes this barometer worth more—much more—than instruments costing just a little less.

Accuracy is imparted by a new and more effective vacuum process of filling; by the all metal case, having uniform thermal expansion, as compared to the irregular expansion of wood backs; and the attached thermometer, which aids in applying temperature corrections.

76890

CENCO MERCURIAL BAROMETER

$25.00

CENTRAL SCIENTIFIC COMPANY

SCIENTIFIC INSTRUMENTS — TRADE MARK CENCO REG. U.S. PAT. OFF. — LABORATORY APPARATUS

1700 IRVING PARK BOULEVARD, CHICAGO, ILL.

TO MEET THE NEW SOCIAL GOALS OF SCIENCE:

EVERYDAY PROBLEMS IN SCIENCE

Pieper-Beauchamp

EVERYDAY PROBLEMS IN BIOLOGY

Pieper-Beauchamp-Frank

Plus most complete program of teaching helps now available:

PUPIL'S STUDY-BOOKS in Science or Biology, each ..... $0.80 list
Definite how-to-study instruction, followed up with practice to develop habits of clear, scientific thinking.

STANDARDIZED OBJECTIVE UNIT TESTS, per pad ..... $0.28 list
Factual and major-idea type tests, Forms A and B.

WALL CHARTS OF UNIT GRAPHS, each set ..... $1.00 postpaid
Showing the essential ideas of each unit in graph form. Size 18" x 21", spiral wire binding.

TEACHER'S GUIDEBOOKS ..... Free

Send for free sample materials.

SCOTT, FORESMAN AND COMPANY
CHICAGO ATLANTA DALLAS NEW YORK

A NEW CONDENSER

Patented

The New "STRAIGHT-JACKET" CONDENSER

SPECIAL FEATURES

1. Non-breakable metal inlet and outlet tubes set in molded rubber caps.
2. Jackets replaceable from your regular tubing stock.
3. Molded rubber caps reduce breakage. The condenser can be carelessly placed on a stone table-top and no glass part touches the table.
4. The inlet and outlet tubes can be set at any convenient angles.
5. Real economy — low initial cost. All parts replaceable and interchangeable. Low replacement cost of all glass parts. All glass is annealed and polariscope tested for strains.

No. 4941—STRAIGHT-JACKET CONDENSER. Complete with molded rubber caps and with metal inlet and outlet tubes.

Length, mm.	250	300	400	500	600	750	900
Each	.85	.90	.95	1.00	1.25	1.80	2.75
Lots of 12 each	.76	.81	.85	.90	1.12	1.62	2.47

All parts are separately listed Write for complete circular.

W. M. WELCH SCIENTIFIC COMPANY
Established 1880

1515 SEDGWICK STREET CHICAGO, ILLINOIS, U. S. A.